

**Office of the Secretary of Defense
Director for Program Analysis and Evaluation
The Joint Warfare System Office**

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**Joint Warfare System
Verification and
Validation Plan**

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JWARS/V&V Plan/ver 3.0/13 August, 1998 **Joint Warfare System Verification and Validation Plan**

V&V-T&E WIPT COORDINATION

The following signature and coordination represents WIPT membership endorsement of the concept and framework of the JWARS V&V processes as described in this plan. This is a living document. Changes to the V&V process are anticipated as development of JWARS continues. By signing this coordination sheet the WIPT members are not authorizing or endorsing the resource requirements identified in this plan. WIPT Members with primary V&V responsibility for their organizations are listed below.

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TABLE OF CONTENTS

INTRODUCTION	1
A. APPLICATION DESCRIPTION AND MODELING AND SIMULATION (M&S)	
APPROACH	A - 1
A.1. PROGRAM DESCRIPTION	A - 1
A.2. PROGRAM M&S METHODOLOGY	A - 3
B. MODEL DESCRIPTION	B - 1
B.1. MODEL DESCRIPTION	B - 1
B.2. MODEL DEVELOPER	B - 1
B.3. MODEL CONFIGURATION MANAGER	B - 1
B.4. PROPOSED USE IN DECISION PROCESS (INTEGRATION WITH OTHER METHODS/DATA)	B - 2
B.5. KEY OBJECTS AND FUNCTIONS	B - 5
B.6. OPERATING ENVIRONMENT (INTENDED HOST HARDWARE, SOFTWARE)	B - 5
B.7. KEY SOURCES OF DATA	B - 5
C. APPLICATION M&S REQUIREMENTS AND ACCEPTABILITY CRITERIA.....	C - 1
C.1. MAJOR M&S REQUIREMENT AREAS (OVERVIEW)	C - 1
C.2. REQUIREMENT AREA 1 - WARFARE REPRESENTATION	C - 1
C.3. REQUIREMENT AREA 2 - PERFORMANCE PARAMETERS	C - 2
C.4. REQUIREMENT AREA 3 - LOGISTICS AND READINESS	C - 3
C.5. REQUIREMENT AREA 4 - PROGRAM SUPPORT	C - 3
C.6. REQUIREMENT AREA 5 - SCHEDULE.....	C - 4
D. MODEL CAPABILITY	D - 1
E. MODEL V&V STATUS	E - 1
E.1. LIST OF MODEL OBJECTS AND FUNCTIONS WITH VERIFICATION STATUS AND VALIDATION STATUS GIVEN	E - 1
F. MODEL V&V REQUIREMENTS	F - 1
F.1. LIST OF MODEL OBJECTS AND FUNCTIONS WITH VERIFICATION REQUIREMENTS AND VALIDATION REQUIREMENTS.....	F - 2
F.2. LIST OF VERIFICATION ACTIVITIES TO BE CONDUCTED.....	F - 3
F.3. LIST OF VALIDATION ACTIVITIES TO BE CONDUCTED.	F - 3
G. VERIFICATION AND VALIDATION PLAN.....	G - 1
G.1. OVERVIEW OF JWARS V&V ACTIVITIES.	G - 1
G.2. V&V ACTIVITIES	G - 3
G.3. CM AND JWARS CHANGE REQUESTS (JCRs).....	G - 10
G.4. RESPONSIBLE PARTY(IES)	G - 10
G.5. V&V RESOURCES REQUIRED.....	G - 12
G.6. INTEGRATED V&V ACTIVITY SCHEDULE.....	G - 13
H. SUMMARY.....	H - 1
APPENDIX A: V&V SCHEDULE	APPENDIX A - 1
APPENDIX B: REFERENCED DOCUMENTS	APPENDIX B - 1
APPENDIX C: GLOSSARY OF TERMS.....	APPENDIX C - 1

Table of Figures

Figure 1. JAMIP Management..... A - 2

Figure 2. JWARS Integrated Software Development and V&V Process..... G - 1

Table of Tables

Table G-1. Overview of Required V&V Activities..... G - 10

INTRODUCTION

This is the Verification and Validation (V&V) Plan for the Joint Warfare System (JWARS). The V&V processes described herein have been adapted from previous V&V efforts to comply with the JWARS Software Development Process (SDP) and the JWARS Configuration Management Plan (CMP). The format follows guidance outlined in the Department of Defense (DoD) Verification, Validation, and Accreditation (VV&A) Recommended Practices Guide (RPG) modified, where appropriate, for the JWARS V&V effort. This plan is subject to the approval of the Joint Analysis Model Improvement Program (JAMIP) Steering Committee.

This plan is organized into seven sections:

Section A describes the JAMIP, directed by the Deputy Secretary of Defense (DepSecDef)

Section B describes JWARS,

Section C addresses JWARS requirements,

Section D lists planned JWARS capabilities,

Section E provides current JWARS V&V status,

Section F describes JWARS V&V requirements, and

Section G details the JWARS Integrated Software Development (ISD) and V&V process.

Appendices provide additional information:

Appendix A identifies the V&V tasks and schedule based on the current software development schedule,

Appendix B is a list of references, and

Appendix C is a glossary of terms used to describe the software development products and the V&V processes.

A. APPLICATION DESCRIPTION AND MODELING AND SIMULATION (M&S) APPROACH

A.1. Program Description

A.1.a. Program Name

JAMIP is the parent program of the JWARS Modeling & Simulation (M&S) application.

A.1.b. Program Description

JAMIP is a DepSecDef-directed program designed to:

- upgrade existing joint analytic models and simulations in the near term,
- develop a set of next generation models for the longer term,
- Provide an operations and maintenance program to provide field support and analytic database development and maintenance, and
- develop Joint Data Support (JDS) to improve data for analytic modeling.

The DepSecDef directed the establishment of the JAMIP in May 1995. The JWARS Office was formally established in November 1995, and in June 1996, JDS was designated as the primary data support agency for the JAMIP, including JWARS.

A.1.c. Program Sponsor or Responsible Agency

The JAMIP sponsor is the DepSecDef. JAMIP management is shown in Figure 1. The Executive Committee (EXCOM) is a three star-level group with representatives from the DoD analysis community. Immediate, regular guidance on JWARS activities is provided by the JAMIP Steering Committee. The Steering Committee, a one- and two star-level group with representatives from Program Analysis & Evaluation (PA&E), J-8, other Office of the Secretary of Defense (OSD) organizations, Defense Modeling and Simulation Office (DMSO), and the Services, reports to the JAMIP EXCOM. The Director PA&E set up the JWARS Office to support development and J-8 established the Joint Modeling and Simulation Requirements Group (JM&SRG) to define JWARS requirements. The JM&SRG subsequently stood down and its functions were assumed by a Requirements Integrated Process Team (IPT) and the Joint Warfare Requirements Group (JWARG). These functions may be further delegated to successor group(s).

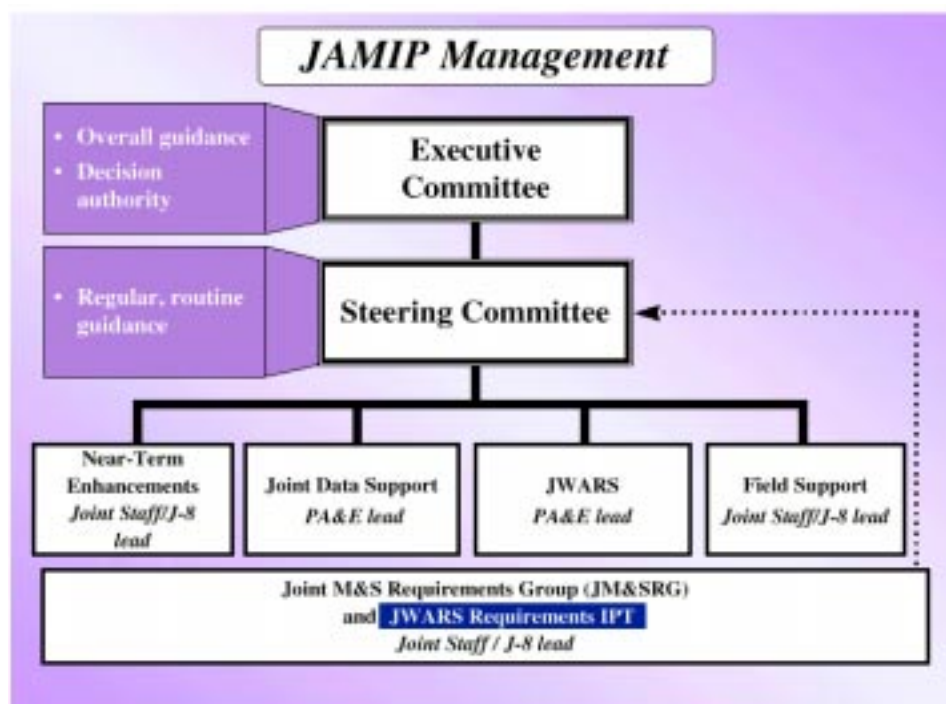


Figure 1. JAMIP Management

A.1.d. Major Program Issues and Objectives

JAMIP objectives included near-term improvements to existing models, developing a new model for mid- and far-term improvement, and integration with the DMSO's High Level Architecture (HLA). Issues include developing a plan and processes to achieve these objectives. Specific concerns include:

- how best to conduct low cost upgrades and enhance current models,
- how to add JDS support to the current models to meet near term needs,
- how to develop JWARS to meet mid and far term needs,
- how to support JWARS with the JDS,
- how to meet DMSO's requirement for integration with the HLA, and
- how best to cooperate with and gain synergy from JSIMS.

From the perspective of JWARS, the primary objective is to provide an effective analysis model that meets or exceeds the established requirements of the Operational Requirements Document (ORD) produced in the requirements process (Requirements IPT / JWARG / successor group(s)).

A.1.e. Program Importance and Major Risks

The results of the JAMIP will improve modeling and simulation for DoD analysis of joint and theater level campaign warfare. Failure to pursue the JAMIP will require continued use for analysis purposes of existing models that don't adequately represent current and future joint warfighting capabilities. The major risks of the JAMIP are that JWARS will not meet the requirements of the analysis community and/or that the JDS being developed will not meet the data requirements of JWARS for analysis.

A.1.f. Program Approach and Methodology Summary

JAMIP will make limited near-term improvements to the existing analysis modeling suite, develop JWARS to meet mid- and long-term needs, and develop JDS to provide data for analysis. JWARS is being developed in a planned, 12 iteration development process using object oriented analysis and design in an iterative, or spiral, development process. At least three versions of JWARS will be iteratively developed during the process. Each new version will build on, and add to the functionality of, the previous version.

A.1.g. Program Schedule Summary

Initial low cost upgrades to existing analytic models were made in 1995 and 1996; enhancements are planned through 1998. JDS development will be ongoing and support will be provided to the models throughout their remaining life. JWARS development is planned through mid-2001 with concurrent HLA integration. The first release of JWARS is planned for March 2000, the second for May 2001, and the third for FY 2002.¹ The JDS is being developed to support JWARS throughout its life cycle.

A.2. Program M&S Methodology**A.2.a. Model or Simulation Requirements**

JAMIP leadership determined that the near-term improvements, JWARS, and the JDS would meet its requirements. Requirements for JWARS are those included in the ORD.

The JWARS representation of Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) will provide the foundation for other simulated activities. The physical environment (i.e., terrain, ocean, air, and space) and its effect on simulated activities will be represented. The simulation must be sufficiently flexible to deal with future warfare concepts, doctrine, systems, and organizations, of the United States, its allies and potential foes. In particular, the simulation must be able to represent and assist in defining and refining the evolving operational concepts of:

- dominant maneuver,
- precision engagement,
- focused logistics, and
- full-dimensional protection of Joint Vision 2010.

JWARS must satisfy the requirements developed by the Requirements IPT / JWARG / successor group(s) led by the Joint Staff / J-8 / Warfighting Analysis Division with support from representatives from the future users of JWARS.

Release 1 will include C4ISR, logistics capabilities and essential functionality that exist in the current MIDAS and TACWAR models. Release 2 will add balanced warfare

¹ These releases are included in the 17 June 1998 Draft ORD version 2.0. This draft was in the coordination process when this plan was written, and is subject to change.

representation and shall be capable of supporting the Planning and Execution application and Force Assessment application described in the ORD. Release 2 will also be capable of replacing TACWAR and MIDAS. Release 3 adds System Effectiveness and Trade-off Analysis, and Concept and Doctrine Development. It shall be capable of replacing CEM, THUNDER, ITEM and SUMMITS.

JWARS will conform to the HLA being defined under the leadership of DMSO. That architecture will be a common technical framework that enables simulations in diverse functional areas, but with comparable levels of resolution to federate with one another (i.e., to execute in parallel and interoperate). However, JWARS is not intended to be interactive, support real-time mission execution, or be linked directly to real-world C4ISR systems.

A.2.b. Model or Simulation Selected

JAMIP leadership has decided to develop JWARS to meet mid- and far-term requirements. JWARS will be a state-of-the-art, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. JWARS is governed by the Draft JWARS ORD and the Key Performance Parameters (KPPs) that were validated by the Joint Requirements Oversight Council (JROC) on 1 Dec 1997.²

A.2.c. Proposed Model's or Simulation's Use in Decision Process

JWARS will be used in joint analytic modeling for planning / programming, modernization assessments, and operational assessments. Users of JWARS will include the CINCs, Joint Task Force (JTF) Commanders / Staff, Services, Joint Staff, Office of the Secretary of Defense (OSD), other DoD organizations, and Industry. Release 2 of JWARS will be capable of supporting planning and execution, and force assessment analysis. Release 3 will be able to perform system effectiveness and trade-off analysis, and Concept and Doctrine Development.

² The 17 June 98 Draft version 2.0 of the ORD also incorporates these KPPs.

B. MODEL DESCRIPTION

B.1. Model Description

B.1.a. Title

Joint Warfare System (JWARS)

B.1.b. Versions

JWARS will be built in three releases:

- Release 1 will include C4ISR, logistics capabilities and essential functionality of the MIDAS and TACWAR models. Warfare functionality, represented by the threads included in Release 1, is included in Appendix C of the ORD (as are the warfare functionalities of the other two releases, for both threshold and objective requirements).
- Release 2 is planned to include balanced warfare representation and to be capable of supporting the planning and execution application, as well as the force assessment applications detailed in Appendix A of the ORD. Release 2 is intended to be capable of replacing TACWAR and MIDAS.
- Release 3 adds system effectiveness and trade-off analysis, and Concept and Doctrine Development (as described in Appendix A of the ORD). Release 3 is intended to be capable of replacing CEM, THUNDER, ITEM and SUMMITS. Warfare functionality requirements for Release 3 are in Appendix B of the ORD.

B.1.c. Scope and Overview

The JWARS application will be a state-of-the art, closed form, and analytic model of multi-sided joint military operations which are founded in the C4ISR process. Its purpose will be to support joint military analysis, primarily focused at the theater operational level of war. JWARS is one of the tools required for the implementation of Joint Vision (JV) 2010. It will provide support in assessing current and future military capabilities within the four emerging operational concepts of dominant maneuver, precision engagement, focused logistics, and full-dimensional protection.

B.2. Model Developer

The Director, PA&E, OSD is conducting the JWARS development effort. The oversight and management is provided by the JAMIP EXCOM and Steering Committee. Requirements are provided by the ORD under the direction of the Joint Staff J-8.

B.3. Model Configuration Manager

The Joint Staff/J-8 Simulations and Analysis Management Division (J-8/SAMD) is responsible for developing the JWARS Configuration Management Plan (CMP). During JWARS development, the Director of the JWARS Office is responsible for managing the JWARS configuration; the J-8-led JWARS configuration control board (JCCB) will be

established to manage the simulation's configuration. Upon the fielding of any beta release, J-8/SAMD will assume responsibility for JWARS CM activities for that version.

B.4. Proposed Use in Decision Process (Integration with Other Methods/Data)

JWARS is being developed to provide a tool for analysis of joint warfighting focused at the theater operational, campaign level. The Office of the Director, PA&E, Joint Staff analysis groups, the Combatant Commands, JTFs, the Services, and Industry will be the users of the tool. The model will be used for:

B.4.a. Planning and Execution

B.4.a.1. Description

To support development of one or more courses of action and risk assessments for U.S. Forces, Allies, coalition partners, and potential adversaries in multiple Smaller Scale Contingencies (SSCs) or Major Theaters of War (MTWs). Includes:

- Situation assessments (e.g., weather, risk),
- Evaluation of force, logistics, C4ISR adequacy, sufficiency, and feasibility,
- Identification of resource shortfalls (e.g., forces, logistics, time),
- Development of force flows and sustainability requirements, and
- Development and evaluation of plans and supporting documents.

B.4.a.2. Conditions

The model must satisfy the following conditions for Planning and Execution uses:

- Preparation shall include establishment and input of applicable data (e.g., current orders of battle, force flows, terrain, dynamic environment, geopolitical constraints, and concepts of operations (CONOPS),
- For crisis action planning, time required for preparation, execution, and analysis shall be no more than 24 hours when a scenario data base exists or no more than 4 days when no scenario data base exists,
- For deliberate planning, time required for preparation (exclusive of data collection and validation), execution, and analysis shall be no more than 14 days for a baseline study and no more than 24 hours for an excursion,
- Must be forward deployable,
- Output data (e.g., Essential Elements of Analysis (EEAs), Measures of Performance (MOPs) and Measures of Effectiveness (MOEs)) properly configured for analysis and presentation must be available within minutes after run completion, and
- Typically 2- to 3-person analytical teams.

B.4.b. Force Assessment**B.4.b.1. Description**

Support identifying those forces required to execute the National Military Strategy (NMS). Determine capabilities and risks for force levels, force design, and force structure. The products of force assessment support determination of the requirements for ensuring that forces are sized, balanced, and stationed to meet NMS. Aspects of force assessment as a major analytic requirement include:

- Analyzing the capability of existing forces, logistics, C4 ISR to meet operational commitments or prospective contingencies and assess risk, effectiveness, tempo, and readiness for multiple contingencies or theaters,
- Analyzing requirements to support building the Program Objectives Memorandum (POM),
- Assessing the capability of proposed out-year force structures required to meet the alternative future scenarios, and
- Determining the impacts of readiness and training on warfighting performance.

B.4.b.2. Conditions

The model must satisfy the following conditions for Force Assessment uses:

- Preparation shall include input of force allocation / force structure, force planning strategies, logistics, C4ISR capabilities to ensure that forces are sized, balanced, and stationed to meet NMS,
- Preparation and execution time shall allow for multiple successive excursions and analysis in no more than a three-month period for studies / assessments (exclusive of data collection and validation), and
- Typically 4-to 6-person analytical team.

B.4.c. System Effectiveness and Trade-off Analyses**B.4.c.1. Description**

Support capability assessments on the performance of major systems and sub-systems (e.g., platform, software, weapon, and sensor) within or among Service assets in campaign-level context:

- Simulating performance of major systems and sub-systems and assessing the impact of their contribution to campaign level objectives through a cause and effect relationship showing the explicit / implicit contribution of each particular system toward achieving the strategic and operational theater objectives for a given scenario,
- Performing trade-off analyses,
- Supporting determination of materiel and support requirements,

- Investigating how well various technologies and proposed systems support achievement of the campaign level objectives, and
- Enabling analyses to support Defense Acquisition Decisions.

B.4.c.2. Conditions

The model must satisfy the following conditions for System Effectiveness and Trade-off analyses:

- Preparation shall include development of detailed input for new and modified systems for inclusion in new or previously run campaign level scenarios,
- Preparation and execution time shall allow for multiple successive excursions and analyses to be run in no more than a three-month period for major (ACAT 1) acquisition programs (exclusive of data collection and validation), and
- Typically 4-to 10-person analytical teams.

B.4.d. Concept and Doctrine Development and Assessment

B.4.d.1. Description

Support evaluation of current and proposed operational concepts and force doctrine by assessing their impact within the context of a theater campaign.

- Conducting studies of warfare doctrines, assessing various CONOPS to conduct warfare,
- Comparing proposed doctrine against alternates and identifying key results (e.g., speed, economy of effort, losses),
- Analyzing specific warfighting implications for war reserves, industrial base, readiness, mobilization, deployment, and installation requirements,
- Assessing the effects of changes in operational concepts, doctrine, and/or tactics at operational / campaign level, and
- Assessing the effects of conceptual warfighting capabilities at operational / campaign level (e.g., JV 2010 concepts).

B.4.d.2. Conditions

The model must satisfy the following conditions for Concept and Doctrine Development Assessments:

- Preparation shall include development of detailed input for new concepts, doctrine, and/or warfare systems for inclusion in new or previously run campaign level scenarios,
- Preparation and execution time shall allow for multiple successive excursions and analyses to be run in no more than a four-month period (exclusive of data collection and validation), and

- Typically 2- to 5-person analytical teams.

Integration with other analysis methods will be determined by the model user. System data will be provided by the JDS. Users will be able to define and input their own data.

B.5. Key Objects and Functions

The ORD's Appendix B, derived from the Universal Joint Task List (UJTL), includes the initial prioritized functionality desired in JWARS. See Appendix B of the ORD for these functions. In Appendix C is a further refinement of the JWARS warfare functionality required for the first two releases of JWARS.

Objects represented in the model are found in the Problem Domain High Level Design Document (HLDD), also referred to as the Object Oriented Analysis (OOA) Model or Analysis Model. This document is available from the JWARS Office.

B.6. Operating Environment (Intended Host Hardware, Software)

JWARS is likely to consist of at least three software processes: a client process, an application server process, and a database server process.

The application process or program may itself consist of one or more processes.

The client component of JWARS will be construed as a universal client.

The server hardware is expected to require 2GB of RAM and two 300MHz CPUs per JWARS session to meet required runtime speeds as specified in the JWARS requirements documents. To maintain the same runtime speeds while running multiple simulations simultaneously, multiples of the above-mentioned RAM and CPU quantities will be required. It is not essential to multiply the server capability if lower runtimes speeds are acceptable.

This architecture of multiple processes can also be accommodated with a single powerful workstation. The critical element of the hardware suite, the system hosting the application server process, must be a 64 bit operating system, with 2GB RAM and at least two 300MHz CPUs.

B.7. Key Sources of Data

JDS will verify the data provided for JWARS. Data imbedded in code or algorithms within JWARS will be validated in conjunction with the V&V process. JDS will develop verified, validated input data sets necessary to initialize JWARS for model runs, to include that necessary for V&V, T&E and alpha and beta testing. The JDS will also formally review all JWARS V&V data artifacts; as a minimum, this will include the CMMS validation, the HLD verification, the DD verification, and the algorithm validation.

C. APPLICATION M&S REQUIREMENTS AND ACCEPTABILITY CRITERIA³

C.1. Major M&S Requirement Areas (Overview)

The ORD for JWARS includes seven main areas and three appendices. The main areas are: General Description of Operational Capability, Threat, Shortcomings of Existing Systems, Capabilities Required, Program Support, Force Structure, and Schedule Considerations. Appendix A describes JWARS applications, Appendix B lists JWARS prioritized UJTL tasks, and Appendix C contains the warfare functionality requirements.

There are three Capabilities Required areas: JWARS Warfare Representation, JWARS Performance Parameters, and Logistics and Readiness.

The Requirements IPT identified 11 Performance Parameters,; the first three of which were identified as KPPs: traceability, V&V and utility. These three KPPs have been validated by the JROC and were specified in the ORD. The 11 Performance Parameters are:

- Traceability (KPP),
- Verification and Validation (KPP),
- Utility (KPP),
- System Integrity,
- Reliability,
- Maintainability,
- Repeatability,
- Ease of Use,
- Portability,
- Classification and Releasability, and
- Run Control.

Refer to the ORD (either the most current draft or approved version) for full requirements information.

C.2. Requirement Area 1 - Warfare Representation

C.2.a. Major Requirement Area Description

The Warfare Representation requirement area is the key to the current and future joint warfare and C4ISR focus of JWARS.

C.2.b. List of Objects and Functions

Warfare Representation requirements include:

- Balanced representation of all forces,
- Joint theater level warfare,
- Realistic environment,

³ The DoD VV&A RPG includes acceptability criteria in this section. Acceptability criteria pertain only to accreditation and are not relevant to the JWARS V&V effort.

- All levels of war,
- Focus on the operational level of war,
- Capable of dealing with current, near-term, and future warfare concepts, doctrines, systems, and organizations for the US, Allies, and potential adversaries,
- Represent multiple nations and coalitions, neutrals, and opposing forces,
- Represent and assist in defining the operational concepts of JV 2010 (dominant maneuver, precision engagement, full-dimension protection, and focused logistics),
- Founded on C4ISR,
- Perception based, and
- Universal Joint Task List (UJTL) prioritized functionality.

C.3. Requirement Area 2 - Performance Parameters

C.3.a. Major Requirement Area Description

The Performance Parameters requirement area includes those that affect the ability of the JWARS user to understand, and have confidence in, JWARS results and to be able to use and maintain the model.

C.3.b. List of Objects and Functions

Performance Parameters are described in the ORD, along with a threshold for measuring the achievement of the requirement.

Performance Parameter requirements include:

- Traceability (KPP),
 - Cause-and-effect relationships and
 - Data references,
- V&V (KPP),
- Utility (KPP),
 - Study execution,
 - Deterministic and stochastic methodology,
 - Multiple levels of resolution, and
 - Run time,
- System integrity,
- Reliability,
- Maintainability,
 - Input data error diagnostics and
 - Runtime error diagnostics,
- Repeatability,
- Ease of use,
 - Training and

- Automated decision support,
- Portability,
- Classification and Releasability, and
- Run control.

The V&V contractor will track all of the requirements in the ORD, including the KPPs and PPs, to determine whether or not they are satisfied. The Requirements Traceability Matrix used in this V&V effort will be shared with the Development Contractors and Operational Test Authority (OTA). A critical portion of each V&V activity (JAD V&V, CMMS validation, etc.) will include requirements traceability, ensuring that the requirements of the ORD are addressed in the appropriate design document and coded in the software.

C.4. Requirement Area 3 - Logistics and Readiness

C.4.a. Major Requirement Area Description

The Logistics and Readiness requirement area is related to developing JWARS for maximum operational availability, portability, and maintenance.

C.4.b. List of Objects and Functions

Logistics and Readiness related requirements include:

- Operational availability,
- Mobility requirements, and
- Maintenance levels.

C.5. Requirement Area 4 - Program Support

C.5.a. Major Requirement Area Description

The Program Support requirement area is related to the planning for maintenance, physical use, resources, support and training for use of the model.

C.5.b. List of Objects and Functions

Program Support requirements:

- Maintenance planning,
- Human Systems Integration (HSI),
 - Manpower constraints,
 - Human System Interfaces,
 - Training, and
 - Safety, health, and critical factors,
- Computer resources,
 - Architecture,
 - Software,
 - CM,

- Hardware, and
- Documentation,
- Other logistics considerations,
 - Facility and shelter,
 - Environmental compliance, and
 - Data,
- C4ISR,
- Transportation and basing,
- Standardization, interoperability, and commonality,
- Mapping, Charting, and Geodesy (MC&G) support, and
- Environmental support.

C.6. Requirement Area 5 - Schedule

C.6.a. Major Requirement Area Description

The schedule requirement area describes the JWARS development schedule requirement for Warfare Refinement for initial and final versions of the model.

C.6.b. List of Objects and Functions

- Release 1 not later than (NLT) March 1, 2000
 - Support force assessment studies for the Quadrennial Defense Review (QDR) force assessment study in FY 00 and FY 01,
 - Release 1 occurs when at least one operational site is capable of supporting force assessment studies for the QDR.
- Release 2 NLT May 1, 2001
 - Occurs when at least one JWARS operational site is capable of supporting planning and execution studies and at least one JWARS operational site is capable of supporting force assessment studies,
- Release 3 FY 2002
 - Occurs when at least one JWARS operational site is capable of supporting system effectiveness and trade-off studies and at least one JWARS operational site is capable of supporting Concept and Doctrine Development studies.

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- Sample Iteration V&V schedule

- V&V activities described in this plan focus on Iterations 1 through 6 (Iteration 6 is the probable Release 2), but V&V activities will continue through the end of JWARS development, now planned for Iteration 12.

Perform V&V on Iteration 4		195d	Mon 8/31/98	Mon 5/31/99
Plan and Schedule V&V Tasks	SME V&V	5d	Mon 8/31/98	Fri 9/4/98
Review It-4 JAD Packages	SME V&V	21d	Fri 9/25/98	Fri 10/23/98
Coordinate User Group/SME Review of It-4 JAD	SME V&V	10d	Mon 10/26/98	Fri 11/6/98
Prepare JAD V&V Results Report for JWARS Office and JAMIP SC	SME V&V	5d	Mon 11/9/98	Fri 11/13/98
JAMIP Approval of It-4 JADs		1d	Mon 11/16/98	Mon 11/16/98
Prepare for User Group/SME Review of It-4 CMMS/HLD/MVC	SME V&V	20d	Mon 11/16/98	Fri 12/4/98
Coordinate Review of It-4 CMMS/HLD/MVC	SME V&V	10d	Mon 12/7/98	Fri 12/18/98
JAMIP Approval of It-4 CMMS/HLD		1d	Mon 12/21/98	Mon 12/21/98
Prepare to Conduct DD Verification and Algorithm Validation	SME V&V	10d	Tue 12/22/98	Mon 1/4/99
Conduct DD Verification and Algorithm Validation	SME V&V	10d	Thu 1/7/99	Wed 1/20/99
Prepare DD Verification and Algorithm Validation Report to JWARS Office		5d	Thu 1/21/99	Wed 1/27/99
Prepare to Perform Implementation Verification		15d	Thu 1/28/99	Wed 2/17/99
Perform Implementation Verification	SME V&V	10d	Mon 2/22/99	Fri 3/5/99
Conduct Results Validation	SME V&V	30d	Fri 4/9/99	Thu 5/20/99
Prepare It-4 JWARS Interim V&V Report	SME V&V	60d	Mon 3/8/99	Fri 5/28/99
Deliver It-4 JWARS Interim V&V Report to JAMIP	SME V&V	0d	Mon 5/31/99	Mon 5/31/99

D. MODEL CAPABILITY

JWARS is in Iteration 3 development and has limited current capability. Capabilities planned for Release 1, Release 2, and Release 3 are described in the previous section.

E. MODEL V&V STATUS

The process for JWARS V&V began on 26 September 1997 when BMH-IMC received award of Delivery Order 01 to the JWARS Block 2, V&V Agent contract.⁴ In the period after contract award the JWARS office formed a V&V Oversight Group composed of Joint Staff, Service, DMSO, and MITRE V&V experts to work with the V&V agent to develop a refined V&V process and plans. In early 1998, after the JAMIP Steering Committee directed integration of the V&V and test and evaluation (T&E) efforts, a V&V-T&E working group IPT (WGIPT, later revised to WIPT) was formed to plan and coordinate the integration and specific V&V and T&E planning and activities. The active V&V process for JWARS has begun and will be conducted IAW this plan, upon acceptance by the JAMIP Steering Committee.

E.1. List of Model Objects and Functions With Verification Status and Validation Status Given**E.1.a. Verification Status and Validation Status**

As of 28 July 1998, the following V&V activities have been completed or are in-progress:

- (1) Iteration 1 and 2 :
 - (a) Joint Application Design (JAD) packets have been verified and validated by the JWARS Users subgroups and CCB-designated SMEs,
 - (b) The Conceptual Model of the Mission Space (CMMS) validation package has been developed, and
 - (c) the High Level Design verification package is under development.
- (2) Iteration 3 :
 - (a) Joint Application Design (JAD) packets have been sent to the JWARS Users subgroups and CCB-designated SMEs for V&V activities.

Copies of interim V&V reports are available from the JWARS Office.

⁴ BMH-IMC is the general partnership of BMH Associates, Inc. (BMH), and Innovative Management Concepts, Inc. (IMC). The general partnership, operating as JWARS V&V, was awarded the Block 2 V&V Agent contract on September 26, 1997.

F. MODEL V&V REQUIREMENTS

The requirement to conduct V&V of JWARS is included in the ORD. The JWARS Office awarded a contract to BMH-IMC (henceforth: the V&V contractor), in September 1997, to satisfy this requirement. Delivery Order 01 under this contract began on September 26, 1997. The first task under this Delivery Order is to prepare and maintain the V&V Plan for JWARS. Active V&V has begun and will be modified as directed by the plan after the JAMIP Steering Committee's acceptance of the plan. V&V responsibilities include facilitating V&V activities conducted by the Government. This task area includes the following activities (taken from JWARS Independent V&V Delivery Order 01):

- Coordinating with the JWARS Users subgroups regarding the capabilities of the simulation to be reviewed,
- Assisting the Government in assigning areas for review to teams of subject matter experts (SMEs),
- Coordinating the actual V&V reviews,
- Recommending tests to be conducted by the JWARS lead developer, and
- For each major set of V&V activities--corresponding to one or more JWARS development cycles--documenting findings in a V&V Report for use by the Government in accreditation.

The delivery order requires the Contractor to obtain Government approval for each V&V Report.

JWARS V&V activities (see dashed lines in Figure 2) include:

- Joint Application Design (JAD) V&V,
- Conceptual Model of the Mission Space (CMMS) validation,
- Model Validation Criteria (MVC) development and approval,
- High Level Design (HLD) verification,
- Detailed Design verification,
- Algorithm validation,
- Implementation verification, and
- Results validation.

Each activity has been classified as either *verification*⁵ or as *validation*.⁶ If the product is compared to a design the activity is classified as verification. If a product is compared to the real world the activity is classified as validation.

F.1. List of Model Objects and Functions With Verification Requirements and Validation Requirements.

JWARS objects and functions are nominated in the process-oriented JWARS CMMS development process. The JWARS CMMS describes functionality and behaviors inherent in joint military operations. Joint Application Design (JAD) packages provide candidate objects. The model objects and functions are also captured in the object-oriented Problem Domain High Level Design Document (HLDD). The HLDD describes the tasks, entities and interactions of interest to the JWARS program. Specific candidate JWARS development model objects and functions are versions of these identified in the JWARS Object Model. The most current documents will be referenced in the V&V documentation that results from the conduct of JWARS V&V activities. In addition, the analytic MOPs that JWARS is required to produce or support have been developed by a parallel Warfare Refinement process, and will be incorporated into the appropriate design documents.

Non-military domain JWARS modules such as the simulation engine, input-output models, the graphical user interface, and data logging and analysis models will be verified. The accuracy of these non-military domain modules will be compared to the developer's conceptual design.

JWARS modules that represent elements of the real world military domain such as forces, units, entities, the processes associated with each, and the interactions among them will be validated. These military domain modules will be compared to the real world to determine their accuracy.

F.1.a. Correlation to List of Activities in Sections F.2. and F.3.

Paragraphs F.2. and F.3. identify the specific V&V activities that will be performed to verify and validate the JWARS simulation.

F.1.b. Importance or Risk of Not Performing V or V.

The risks associated with not performing V or V of JWARS include:

- Incorrect or misleading simulation results,
- Impact on the quality of the resulting software,
- Lack of user confidence in model output,
- Difficulty gaining user acceptance and accreditation of the model,
- Increased life cycle cost to fix model deficiencies after fielding, and

⁵ Defined in *Directive 5000.59* as: The process of determining that a model implementation accurately represents the developer's conceptual description and specifications.

⁶ Defined in *Directive 5000.59* as: The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model.

- Not meeting a JROC approved KPP of the ORD.

F.2. List of Verification Activities to be Conducted.

- JAD package verification,
- HLD verification,
- Detailed Design verification, and
- Implementation verification.

F.3. List of Validation Activities to be Conducted.

- JAD package validation,
- CMMS validation,
- Model Validation Criteria (MVC) development and approval,
- Algorithm validation, and
- Results validation.

G.1. Overview of JWARS V&V Activities.

The diagram illustrates the V-model for the development and testing of a Campaign Level Warfare (CLW) system. The left side of the V represents the development and testing phases, while the right side represents the requirements and the real world.

Left Side (Development and Testing):

- Requirements:** Military and Environment Representation Requirements, User Requirements, System Design Requirements.
- JADs (Joint Analysis and Design):** A central vertical column representing the analysis and design process.
- Development Phases:**
 - High Level Design (HLD)
 - Detailed Design
 - M&S Code
 - M&S Implementation Integration Test Results
 - Implementation Data
 - Application Software
 - Interim V&V Reports
- Testing and Evaluation Phases:**
 - Model Validation
 - High Level Design Verification
 - Detailed Design Verification
 - Code Verification
 - Implementation Verification
 - Results Validation

Right Side (Requirements and Real World):

- ORD (Operational Requirements Document):** The top-level requirements document.
- Requirements:** A box representing the requirements phase.
- Software Development:** A box representing the software development phase.
- Real World:** A box representing the real world.
- Validated Software:** A box representing the validated software.
- Conceptual Model:** A box representing the conceptual model.

Legend:

- Requirements (Green)
- Software Development (Purple)
- Real World (Blue)
- Validated Software (Orange)
- Conceptual Model (Yellow)

Notes:

- Rectangles denote products, the oval denotes the actual "real world".
- The conceptual model includes assumptions, algorithms, architecture, intended applications, and availability of appropriate input data. Conceptual model validation is based on the validation/verification of its components.

TEST & EVALUATION * **ACCREDITATION**

* as appropriate

Data certification is an integral part of the JWARS software development and V&V process; a separate data certification plan will be prepared by JDS. When the plan is available, V&V activities related to data certification will conform to the plan.

The figure is structured to depict the relationships among five major components of the process:

- UNCLASSIFIED

- The software development products that are produced throughout the process (purple boxes),
- The conceptual model (yellow box) (assumptions, algorithms, architecture, intended applications, and availability of appropriate data), and
- The V&V activities associated with each software development product (dashed arrows).

The final products (orange boxes) of this process are:

- Validated application software,
- Certified data, and
- Summary V&V reports.

These final products are the primary basis for JWARS Accreditation and Test and Evaluation (T&E). T&E activities will be conducted in accordance with a Test and Evaluation Plan. Due to potential overlap in processes and report data requirements, V&V and T&E activities will be integrated to the maximum extent possible to minimize duplication of effort. Planning for this integration is on going and will be managed by the V&V-T&E working IPT. Future versions of this plan will address specific V&V-T&E integration.

The V&V process will take advantage of the JWARS Quality Assurance (QA) process as outlined in Appendix G to the Software Project Management Plan, version 1.1, dated 06 DEC 1997. The V&V Agent will coordinate V&V activities, through the JWARS Office, with the Developer's QA Agent, in order to obtain the results of all reviews and inspections conducted for the QA process, for use in the V&V process. Where possible, the V&V Agent will use the QA process results to expedite and prevent unnecessary duplication of tests and reviews. However, the V&V process will remain independent of the Developer's QA process.

V&V activities that result in the identification of problems or potential problems will be reported and tracked, in accordance with the CMP. Solutions, if available from the Development or V&V Agents, will be proposed. The entire process, and the results, will be incorporated into the interim and final V&V reports.

A single Derived Requirements list will be maintained for use by the JWARS Office, the Development Contractors, the OTA, and the V&V Contractor. This list will be used by the V&V Agent as an aid to requirements traceability throughout the V&V process. The V&V-T&E WIPT will direct activities related to the list.

G.2. V&V Activities

This section provides a detailed description of the Figure 2 JWARS integrated software development and V&V process that describes:

- The type of activity,
- The sequencing of each software development and V&V activity,
- The party responsible for each activity,
- The techniques that are employed for each V&V activity, and
- The products of each V&V activity.

The first reference in this document to each V&V technique is accompanied by a reference to the DoD VV&A RPG paragraph and page number on which a detailed description of that V&V method is provided. Subsection G.3. addresses the relationship between JWARS V&V and CM functions. Subsection G.4. identifies the party(ies) responsible for conducting each V&V activity (key players).

V&V-management interface, coordination between the V&V Agent and other members of the JWARS development team, and V&V Agent internal coordination activities are all required as part of the V&V effort. They have not been specifically described in the following paragraphs, however, as they are ‘overhead’ associated with conduct of specific V&V activities.

G.2.a. JAD V&V

The JAD packages are the “interface” documents between JWARS requirements and the JWARS Development Contractors. Each JAD contains the information needed to identify the contents and constraints for each thread. Each JAD package contains requirements derived from the ORD.

The purpose of JAD V&V is to ensure that derived requirements and interpretations in each package accurately reflect the original requirements, and can be traced to those requirements, and that all original requirements have been specifically addressed in the JADs. JAD verification ensures that the JADs contain all of the required types of information, and are formatted correctly, as defined by the JWARS Office.

The method employed for initial JAD V&V will be traceability assessment (see DoD VV&A RPG para. 4.1.2.10, pg. 4-12) where requirements described in the JAD are traced back to military and environment representation requirements, user requirements, applicable CMMS components, and system design requirements included in the ORD. JAD verification will be by inspection, and will use automated tools developed by the DMSO-sponsored CMMS-Toolset program.

The validation process begins with the JAD sessions conducted with the user representatives and SMEs. The V&V Agent will attend each session and record the issues raised by the user representatives and SMEs. This issue list will be provided after the session to the JWARS Office and will show the issue, the discussion about the issue, and provide a place for the JWARS Office to track the disposition of the issue. The

JWARS Office should concur or non-concur with the SME recommendations, and provide rationale for its decision.

The product of the JAD V&V review is a report that documents the results of the V&V process, including recommended actions in those cases where JADs are not validated or verified. The report will be forwarded to the JAMIP Steering Committee for each iteration. The approved JAD will be used in the remaining JWARS development and V&V processes.

During the JAD review process the JWARS Office will develop a set of Derived Representation Requirements (DRRs) which will be used by the V&V Agent to begin the process of developing initial Model Validation Criteria (MVC). The MVC process will continue through the HLD Verification process. At the completion of HLD, a complete set of MVCs for each Iteration will be developed for use in the RV process, in an iterative process between the V&V Agent, the JWARS Office, and the user community.

G.2.b. CMMS Validation

The CMMS is the first abstraction of the real world. In the JWARS SDP the CMMS is a representation of entities, processes, and interactions that need to be simulated by JWARS. The representations which comprise the CMMS are developed by contractor SMEs. These SMEs use their knowledge of the domain, and authoritative sources, to document the applicable entities, processes, and interactions required for the CMMS.

The purpose of the CMMS validation is to ensure that authoritative sources have been used for CMMS development, that the format for documentation meets Validation Agent standards, and that the representations are an accurate portrayal of the entities, processes, and interactions.

The method employed for CMMS validation is user SME review (see DoD VV&A RPG para. 4.1.1.5, pg. 4-5).

CMMS validation is a part of the JAD validation process for the portion of the CMMS that pertains to the JAD activity. The applicable portion of the CMMS relating to a specific JAD is extracted and provided to the SMEs for validation review.

CMMS validation includes the identification of the physical elements (systems, entities, units, and forces) and the behavior processes (missions) associated with the physical elements. The CMMS is validated by comparing the identified set of physical elements and their respective processes and interactions to the real world. A specific example would be to validate a CMMS that includes an Air Force wing and its planning process for the execution of an air tasking order (ATO). The validation process would be the process of comparing the CMMS description of the air wing with authoritative source documents describing the wing and descriptions of the wing by subject matter experts designated by the Air Force. The wing's planning and ATO execution processes would be validated in the same way. The product of the CMMS validation for an iteration is a CMMS validation report to the JAMIP Steering Committee.

G.2.c. MVC Approval

MVC are developed to provide a basis for results validation and algorithm validation.

From the DoD VV&A Recommended Practices Guide, page 1-8:

“An important aspect of validation to remember is that validation will not say a simulation is good or bad. It simply measures the difference between simulation outputs and the real world. The user then decides if that difference is small enough for the simulation to be used in a specific application and if the results when used in that application will have the expected accuracy.”

MVC are used to express, in advance, just how “small” the differences have to be for the simulation to be useful in its intended applications.

MVC establish the real-world basis of comparison that supports the subsequent validation steps. The criteria define the level of representation required of the simulation in terms of resolution, fidelity, and accuracy. MVC are composed of two parts: validation criteria elements, and the validation criteria metrics associated with each element. Validation criteria elements identify the features (functions, processes, and entities) within a simulation that are considered of sufficient importance to be compared to their real-world counterparts as part of the validation process. The validation criteria metrics then establish, quantitatively and from the perspective of the intended uses of the simulation, how closely the selected simulation features have to match their real-world counterparts.

The initial development of MVC is done by the V&V Agent, and then modified as required by the JWARS Office, Development Contractors, and the Users subgroups. Approval of the MVC is the responsibility of the JWARS Users subgroups. The Development Contractor may propose a set of criteria initially, and the Validation Agent may suggest modifying that initial set or propose an alternative set.

The method employed for MVC approval is review by the user group analysts and SMEs.

The product of the MVC approval is a report that thoroughly documents the resultant criteria. The approved criteria will be used in the remaining JWARS development and V&V processes.

For example: in the real world, for a given aircraft, fuel consumption is dependent on the type of aircraft, the power setting, the speed, the configuration, the temperature, and the altitude. Assume that for initial JWARS use, the only related requirement is that aircraft range be modeled as a function of fuel consumption. One possible MVC could be that the modeled rate must match the average consumption rate for that type of aircraft across all operating conditions (power settings, speeds, configurations, temperatures and altitudes). Note, however, that such a criterion is the equivalent of saying that the model shall use a user-supplied constant as the fuel consumption rate. That sort of “derived” data from an authoritative source may not be available. Alternatively, much more demanding criteria could be proposed and approved, if required, based upon the intended use of the simulation. An observed model output is compared to the real world fuel consumption by SMEs, and if the observed output is acceptable, it satisfies the MVC for this area.

G.2.d. HLD Verification

HLD development is the first step in the design stage for solving the “problem” -- making decisions on how the subsystems or components interact to make the systems work. The HLD is based on:

- Mission space representation requirements that flow from the real world,
- Intended use, and
- System design requirements.

The HLD provides a level of design required to understand how the components of the product technically work and whether the planned functionality for the software addresses mission space and system design requirements.

The purpose of the HLD verification is to ensure that mission space representation requirements, given JWARS’ intended use and system design requirements, are addressed in the planned functionality for software models.

The methods employed for HLD verification include user analytic and SME review (including structured walk-throughs, where appropriate) and traceability assessment. The V&V Agent will make the HLD document available for review, accept inputs and comments, and work with the JWARS Office to incorporate user/SME inputs.

The product of the HLD verification activity is a report that documents the verification results, and includes recommended actions in those cases where a HLD is not verified.

G.2.e. Conceptual Model Validation

The Conceptual Model (see DoD VV&A RPG para. 1.2.2, pg. 1-6) is the simulation developer’s way of translating modeling requirements into a Detailed Design framework, from which the software that will make up the simulation can be built. These modeling requirements will include military domain requirements derived from CMMS products, intended use requirements from the MVC product, system design requirements, and the HLD. The Conceptual Model should include a description of the equations and algorithms that will be used to meet requirements, as well as explicit descriptions of any assumptions and limitations made or associated with the equations, algorithms, or solution approaches that are used to solve a modeling problem. The conceptual model also should identify how these assumptions and limitations might impact the simulation’s ability to meet the JWARS requirements.

Conceptual Model validation is not specifically performed for JWARS but is achieved by verification or validation of the component software development products that comprise the Conceptual Model as described in the previous paragraph.

G.2.f. Detailed Design Verification and Algorithm Validation

The V&V Agent has primary responsibility for conducting Detailed Design Verification and Algorithm Validation. The Detailed Design provides the information a software engineer needs to write code. This includes sequencing information, algorithms, assumptions (mathematical, structural, and causal), interface protocols, data, etc. Each

element of the Detailed Design must be traceable to the HLD, and vice versa.

Algorithms are the mathematical and logical formulation of the processes that must be represented in a simulation. Algorithms require careful development and/or selection. Mathematical correctness and completeness must be balanced against intended use and the practicalities of implementation.

The purposes of the Detailed Design verification and algorithm validation are:

- to ensure that the content of the Detailed Design is complete
- to ensure that each component of the Detailed Design traces to the HLD
- to assess whether the algorithms or mathematical approximations specified in the Detailed Design are sufficiently accurate vis-a-vis the real world, considering their intended uses,
- to determine the operational and analytical implications of the identified assumptions, and
- to determine if the data required for these algorithms and approximations are available and have been validated.

The methods planned for the Detailed Design verification include:

- traceability assessment,
- data analysis (see DoD VV&A RPG para. 4.1.2.3, pg. 4-8),
- interface analysis (see DoD VV&A RPG para. 4.1.2.5, pg. 4-9),
- algorithm analysis,
- inspection, and
- review.

Although the V&V Agent is responsible for detailed design verification, the SMEs that were designated during the JAD and HLD process by the CINCs and services will be invited to participate in the verification of detailed design. Algorithm analysis is not specifically addressed as a V&V technique in the DoD VV&A RPG, but the RPG includes the assessment, by expert mathematicians and modelers, of the accuracy and adequacy of a given algorithm for an intended purpose; such assessments may require reverse-engineering selected algorithms.

The product of Detailed Design verification and algorithm validation is a report (the Detailed Design Verification and Algorithm Validation Report) that documents the Detailed Design verification and algorithm validation results, and includes recommended actions in those cases where the Detailed Design is not verified or the specified algorithms are not validated.

G.2.g. Code Verification

Code is the actual application software. Since software is seldom written without error, individual software components or modules are tested to ensure that they function properly. Code verification is the lowest level of software testing performed, and is always performed by the software developer based on a test plan that traces code functionality back to the Detailed Design.

The methods that may be employed for code verification include:

- functional testing (see DoD VV&A RPG para. 4.1.3.12, pg. 4-19),
- interface testing (see DoD VV&A RPG para. 4.1.3.14, pg. 4-20),
- regression testing (see DoD VV&A RPG para. 4.1.3.19, pg. 4-23), and
- traceability.

The specific method(s) required to facilitate code verification will be selected by the JWARS Developer and executed by the development contractors. The V&V Agent will review the code verification reports and use the results for implementation verification.

G.2.h. Implementation Verification

Implementation verification is the set of V&V Agent activities that verify that the developer has correctly implemented the detailed design for that Iteration. JWARS implementation verification will be conducted while the software developer executes the test plan to demonstrate the capability and functionality of the system in an operational software environment similar to the user environment in which the simulation will be employed.

The purpose of the implementation verification is to ensure that the individual software components and modules that comprise the simulation system perform according to their respective Detailed Designs.

The methods that may be employed for implementation verification include:

- sensitivity analysis (see DoD VV&A RPG para. 4.1.3.20, pg. 4-23),
- compliance testing (see DoD VV&A RPG para. 4.1.3.7, pg. 4-16),
- user interface testing (see DoD VV&A RPG para. 4.1.3.14, pg. 4-20),
- alpha testing (see DoD VV&A RPG para. 4.1.3.2, pg. 4-13),
- beta testing (see DoD VV&A RPG para. 4.1.3.4, pg. 4-15),
- regression testing (see DoD VV&A RPG para. 4.1.3.19, pg. 4-23),
- statistical techniques (see DoD VV&A RPG para. 4.1.3.22, pg. 4-25),
- visualization (see DoD VV&A RPG para. 4.1.3.27, pg. 4-34), and
- traceability assessment.

The V&V Agent will work with the developers to ensure that sufficient testing is conducted to facilitate implementation verification.

The product of implementation verification is a report that documents the implementation verification results, and includes any deficiencies discovered and the corrective actions taken to address these deficiencies. The user community will be invited to participate in the implementation verification process through participation in some or all of the Implementation Verification activities.

G.2.i. Results Validation

The V&V Agent has primary responsibility for conducting Results Validation. Results Validation (RV) compares the responses of the simulation with known or expected (estimated) behavior from the subject it represents, to ascertain that the simulation's responses are sufficiently accurate for the simulations intended use. The process includes comparison of simulation outputs with, in order of preference: operational, exercise or

test databases, the results of controlled tests, sensitivity analyses, or expert opinion. RV is conducted on the integrated (whole) simulation as well as selected models within the simulation. The MVC of Section G.2.c serve as the basis for the comparisons accomplished under Results Validation.

The purposes of results validation are:

- to determine the extent to which MVC have been met for individual models and the system as a whole, based on demonstrated software functionality and accuracy for the fieldable version of the system software, and
- to document the capabilities and limitations of the individual models and the simulation system as a whole, from the perspective of their intended uses.

The methods employed for results validation will include functional testing (see DoD VV&A RPG para. 4.1.3.12, pg. 4-18), interface testing, regression testing, sensitivity analysis, compliance testing, statistical techniques, visualization, and traceability assessment. For the Iterations of JWARS that will be Alpha and/or Beta tested, RV will be conducted during those tests. For Iterations that will not be Alpha or Beta tested, RV will be conducted during individual thread testing and after Iteration development and next subsequent fielding.

The product of results validation is a report that assesses model functionality, resolution, fidelity, and accuracy compared to the real world, based on the MVC. JDS, in coordination with the services, will collect and provide comparison data for RV. Comparison data is a collection of data from real-world operations, exercises, testing, evaluation results, engineering studies, and platform performance. The analytic user community will be provided the products of the RV effort via the JWARS Homepage, JUG Subgroup User Page, and SIPRNET. The CINCs, JDS and Services will participate in the Alpha and Beta testing, as well as be requested to participate in the RV effort, in order to complete the RV activities for a specific Iteration.

G.2.j. V&V Review Process

When a V&V process starts, the JWARS Office or the V&V Contractor will send an e-mail notification to the user subgroup members. Draft V&V products will be made available for review through the V&V page on the JWARS Users Group/Subgroup homepage. The V&V page will consist of a table containing a row for each of the V&V processes and/or products, and a column for each Iteration 1 through 6. Each cell will represent the status of the process and/or product for each iteration. For those iterations for which a process or product is inapplicable or not yet begun, the appropriate cell will be empty. For those iterations for which a process/product has been begun, the appropriate cell will be marked with a "C" if it is complete, or with "NR" if it needs review. When clicking on a cell marked "C" the viewer will be linked to a "pdf" file of the final product. When clicking on a cell marked "NR" the viewer will be linked to a page containing the activities which have yet to be performed, and links to the relevant sites or documents.

It is anticipated that the above use of the web for V&V activities will reduce SME and analytic user travel, reduce the number of face-to-face meetings, and make the V&V process open to the entire DoD analytic community.

G.3. CM and JWARS Change Requests (JCRs)

The V&V Agent will comply with the practices and requirements set forth in the JWARS Configuration Management Plan (CMP), and with the JWARS development functions, responsibilities and authorities related to V&V Agent activities and the V&V process. V&V activities will be conducted during the development process, including both generating and responding to requests for changes in the system. The V&V processes described in this plan conform to those identified in Table 3-4, CM Integration with VV&A (although the current scope is limited to V&V only).

V&V plans and reports will be created in accordance with the formats in the DoD RPG, per direction of the JWARS Office. JCRs submitted by the V&V Agent will comply with the Configuration Control procedures in the CMP. The V&V Agent will support JWARS Office actions in the change approval and control process. This V&V Plan, upon approval of the JAMIP Steering Committee, will be managed to comply with the JWARS CMP.

G.4. Responsible Party(ies)

There are three principal groups responsible for conduct of V&V activities. They are:

- The Validation Agent,
- The Verification Agent, and
- The V&V Agent

Table G-1 provides an overview of required V&V activities. These are described as signature or development responsibilities, day-to-day activity responsibilities, and facilitator responsibilities.

Table G-1. Overview of Required V&V Activities

Process or Product	Approval Authority	V and/or V Responsibilities	Facilitators
JAD V&V	JAMIP SC	JWARS Users Subgroups as Validation Agent BMH-IMC as Verification Agent	V&V Agent (BMH-IMC)
CMMS Validation	JAMIP SC	JWARS Users Subgroups as Validation Agent	V&V Agent
MVC Approval	JAMIP SC	JWARS Users Subgroups as Validation Agent	V&V Agent
High Level Design Verification	JAMIP SC	JWARS Users Subgroups and Verification Agent	V&V Agent
Detailed Design Verification	JWARS Office Director	Verification Agent	NA
Algorithm Validation	JWARS Office Director	V&V Agent	V&V Agent
Code Verification	JWARS Office Director	JWARS Development Contractors	NA
Implementation Verification	JWARS Office Director	Verification Agent	NA
Results Validation	JAMIP SC	V&V Agent	V&V Agent

G.4.a. The Validation Agent

The Validation Agent is the organization designated by the M&S sponsor to perform validation of a model, simulation, or federation of models and/or simulations (DoD 5000.61 definition). The Validation Agent for JWARS is the DoD analytic user community. The subgroups include members from DoD warfighting and customer / user commands, as needed to provide subject matter expertise for validation criteria, validation of the JADS and CMMS, review of the HLD, algorithm validation, and for validation of the models and simulations. The US Navy M&S Fleet Project Team (FPT) is an example of an existing Validation Agent from which lessons learned for stand-up and operations can be applied.⁷

The JWARS Users subgroups play a crucial role in software development. The success of JWARS will rest principally on the strength of users' acceptance of the model. The JWARS Office decided early to form a close coupling with future JWARS users. The group is composed of analysts from the same organizations as the Requirements IPT / JWARG / successor group(s). Perhaps the most important function of the User subgroups will be their role in the formulation and approval of Essential Elements of Analysis (EEAs), and MOEs. These items form the basis for Model Validation Criteria (MVC) against which research, analysis, software design and implementation, and RV will proceed. The User subgroups also provide the forum for presenting incremental insertions of working software systems for review and criticism, before they reach the testing stage. The JWARS Users subgroups will also provide JWARS with a link to the Services and combatant commands for obtaining operational data and expertise for use in the V&V effort. Validation issues that can't be closed at the User subgroup level will be elevated to the Requirements IPT / JWARG / successor group(s). If unable to be resolved at that level the JAMIP Steering Committee and/or EXCOM will be the decision authority.

The V&V Agent welcomes participation from all future JWARS users in the analytic community during Validation activities. However, in order to ensure that each Service plays a part in these critical activities, participation from the primary Service analysis agencies is sought out and included in each Validation action. These agencies include: Army Concepts Analysis Agency (CAA), Air Force Studies and Analysis Agency, Navy N-81, and Marine Corps Combat Development Command (MCCDC). Each of these organizations is represented on the V&V-T&E WIPT and the JAMIP Steering Committee. The Service Representatives in the JWARS Office will assist the V&V Agent by coordinating with their Service analytic organizations to support Validation activities.

The V&V Agent will ensure, to the best of its ability, that the inputs of the SMEs and analytic user community are considered in each step of the V&V process. The V&V Agent will track inputs that are rejected or partially implemented in the development and inform the provider of the input.

⁷ The V&V Agent has supported the stand-up of the USN M&S FPT and continues to provide support during ongoing FPT operations.

G.4.b. The Verification Agent

The Verification Agent is the organization designated by the M&S sponsor to perform verification of a model, simulation, or federation of models and/or simulations (DoD 5000.61 definition). Verification Agent activities normally require significant software developer interaction since verification is “the process of determining that a model implementation accurately represents the developer’s conceptual description and specifications.” The V&V Agent (BMH-IMC) is the JWARS Verification Agent.

G.4.c. The V&V Agent

The V&V Agent is responsible for monitoring and oversight of V&V activities, and for providing technical support to the Verification Agent and the Validation Agent during conduct of JWARS V&V activities. The V&V Agent is also responsible for documenting the results of each V&V activity performed during JWARS development. BMH-IMC will serve as the V&V Agent for JWARS.

G.5. V&V Resources Required

Resources for V&V activities are provided by four organizations or types of organizations: the V&V Agent (BMH-IMC), the JWARS Office, the JWARS Development Contractors, and the services (User subgroup members and/or SMEs).

Available V&V Agent resources are determined by the level of effort (LOE) required. The JWARS Office, with the guidance and approval of the JAMIP, will determine the LOE required on each delivery order. For Delivery Order 1 (DO1), two full-time equivalents (FTEs) were provided. This LOE was sufficient for initial planning and preparation for the JWARS V&V effort. For future delivery orders an LOE will be established based on the anticipated work, and the available funds.

JWARS Office resources for the V&V effort are made available on an as-required basis. Currently, there is one Service representative assigned to day-to-day management of the V&V and T&E effort as an additional duty. Limited FFRDC (currently MITRE) support is provided to support the JWARS Office V&V effort. Other JWARS Office personnel conduct V&V-related activities when their expertise is required.

JWARS Development Contractors (GRCI, CACI, and their subcontractors) provide products for the V&V effort. However, the V&V Agent does not directly task the Development Contractors; requests for products are passed to the Development Contractors through the designated Service representative. The V&V Agent has been directed by the JWARS Office to minimize requirements for the developers to create special products for V&V activities.

The services provide analytic users and SMEs to the JWARS Users subgroups for validation support. The initial estimate of User/SME resource requirements for validation of Iterations 1 through 6 products is 43,000 hours. The JWARS Office and the V&V Agent are working to reduce this requirement in three ways:

- by providing as many products as possible in electronic formats,
- by combining all practical validation support testing with the T&E process, and

- by asking the services to designate specific analytic Users/SMEs to reduce the total review hours required.

G.6. Integrated V&V Activity Schedule

Due to the integration of V&V activities with the JWARS SDP, the V&V activity schedule (Appendix A) will be driven by the software development schedule. In 1998 JWARS development was delayed due to warfare refinement requirements changes directed by the JAMIP Steering Committee. A Joint Warfare Requirements Group (JWARG) was established to review the requirements and update the ORD. JWARG work in March, April and May 1998 caused the JWARS Office to conduct major rework to the Iterations 1 and 2 JAD packages and Iterations 1 and 2 design products. In many cases, in order to make up the schedule delay, Iteration 1 and 2 V&V processes and products will be combined.

The schedule in Appendix (A) is tied to the development schedule. In each iteration the V&V process begins at iteration start, follows the development process to conduct V&V activities when products are available, and ends with post-development results validation. For those iterations that will be Alpha and/or Beta tested, the results validation is integrated with that testing.

H. SUMMARY

This V&V Plan is the summary of the best efforts of the JWARS V&V Oversight Group, and the V&V-T&E WIPT. Each participant in the V&V planning process understands that much will be learned as this process is executed and that the processes and products described will change over time as experience is gained in conducting an integrated V&V process during a major model development.

Comments on this plan should be sent to CDR Steven Barnes in the JWARS Office or Mike Metz at Innovative Management Concepts, Inc. via the following addresses/numbers:

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JWARS/V&V Plan/ver 3.0/13 August, 1998 Joint Warfare System Verification and Validation Plan

APPENDIX A: V&V SCHEDULE

ID	Task Name	Resource	Duration	Start	Finish
1	Perform V&V on Iterations 1 through 6		540d	Mon 4/27/98	Mon 5/22/00
2	Perform V&V on Iteration 1 & 2 rework		124d	Mon 4/27/98	Fri 10/16/98
3	Plan and Schedule V&V Tasks	SME V&V	5d	Mon 4/27/98	Fri 5/1/98
4	Review Iteration 1 and 2 JAD Packages	SME V&V	7d	Mon 5/11/98	Tue 5/19/98
5	Coordinate User Group/SME Review of Iteration 1 and 2 JAD Packages	SME V&V	15d	Wed 5/20/98	Tue 6/9/98
6	Prepare JAD V&V Results Report for JWARS Office and JAMIP SC	SME V&V	5d	Thu 7/2/98	Wed 7/8/98
7	JAMIP Approval of Iteration 1 and 2 JADs	JAMIP SC	0d	Thu 8/13/98	Thu 8/13/98
8	Prepare for User Group/SME Review of Iteration 1 and 2 CMMS/HLD/MVC	SME V&V	10d	Thu 7/9/98	Wed 7/22/98
9	Coordinate Review of Iteration 1 and 2 CMMS/HLD/MVC	SME V&V	10d	Thu 7/23/98	Wed 8/5/98
10	Prepare CMMS/HLD V&V Report for JWARS Office and JAMIP SC	SME V&V	5d	Tue 8/18/98	Mon 8/24/98
11	JAMIP Approval of Iteration 1 & 2 CMMS/HLD	JAMIP SC	0d	Thu 8/13/98	Thu 8/13/98
12	Prepare to Conduct DD Verification and Algorithm Validation	SME V&V	2d	Fri 7/24/98	Mon 7/27/98
13	Conduct DD Verification and Algorithm Validation	SME V&V	15d	Tue 7/28/98	Mon 8/17/98
14	Prepare DD Verification and Algorithm Validation Report to JWARS Office	SME V&V	2d	Tue 8/18/98	Wed 8/19/98
15	Prepare to Perform Implementation Verification	SME V&V	5d	Mon 8/10/98	Fri 8/14/98
16	Perform Implementation Verification	SME V&V	10d	Mon 8/17/98	Fri 8/28/98
17	Conduct Results Validation	SME V&V	30d	Mon 8/31/98	Fri 10/9/98
18	Prepare Iteration 1 and 2 JWARS Interim V&V Report	SME V&V	4d	Mon 10/12/98	Thu 10/15/98
19	Deliver Iteration 1 and 2 JWARS Interim V&V Report to JAMIP	SME V&V	0d	Fri 10/16/98	Fri 10/16/98
20					
21	Perform V&V on Iteration 3		270d	Mon 5/11/98	Mon 5/24/99
22	Plan and Schedule V&V Tasks	SME V&V	5d	Mon 5/11/98	Fri 5/15/98
23	Review Iteration 3 JAD Packages	SME V&V	20d	Thu 6/18/98	Wed 7/15/98
24	Coordinate User Group/SME Review of Iteration 3 JAD Packages	SME V&V	25d	Fri 7/3/98	Thu 8/6/98
25	Prepare JAD V&V Results Report for JWARS Office and JAMIP SC	SME V&V	3d	Fri 8/7/98	Tue 8/11/98
26	JAMIP Approval of Iteration 3 JADs		1d	Thu 8/13/98	Thu 8/13/98
27	Prepare for User Group/SME Review of Iteration 3 CMMS/HLD/MVC	SME V&V	5d	Mon 8/10/98	Fri 8/14/98
28	Coordinate Review of Iteration 3 CMMS/HLD/MVC	SME V&V	10d	Mon 8/17/98	Fri 8/28/98
29	Prepare CMMS/HLD V&V Report for JWARS Office and JAMIP SC		5d	Mon 8/31/98	Fri 9/4/98
30	JAMIP Approval of Iteration 3 CMMS/HLD		1d	Fri 9/4/98	Fri 9/4/98
31	Prepare to Conduct DD Verification and Algorithm Validation	SME V&V	5d	Fri 9/4/98	Thu 9/10/98
32	Conduct DD Verification and Algorithm Validation		5d	Thu 9/10/98	Wed 9/16/98
33	Prepare DD Verification and Algorithm Validation Report to JWARS Office		5d	Wed 9/16/98	Tue 9/22/98

UNCLASSIFIED

JWARS/V&V Plan/ver 3.0/13 August, 1998 **Joint Warfare System Verification and Validation Plan**

ID	Task Name	Resource	Duration	Start	Finish
34	Prepare to Perform Implementation Verification		10d	Tue 8/22/98	Mon 10/5/98
35	Perform Implementation Verification	SME V&V	10d	Mon 11/2/98	Fri 11/13/98
36	Conduct Results Validation in conjunction with Alpha Testing	SME V&V	130d	Mon 11/16/98	Fri 5/14/99
37	Prepare Iteration 3 JWARS Interim V&V Report	SME V&V	5d	Mon 5/17/99	Fri 5/21/99
38	Deliver Iteration 3 JWARS Interim V&V Report to JAMIP	SME V&V	0d	Mon 5/24/99	Mon 5/24/99
39	Perform V&V on Iteration 4		195d	Mon 8/31/98	Mon 5/31/99
40	Plan and Schedule V&V Tasks	SME V&V	5d	Mon 8/31/98	Fri 9/4/98
41	Review Iteration 4 JAD Packages	SME V&V	21d	Fri 9/25/98	Fri 10/23/98
42	Coordinate User Group/SME Review of Iteration 4 JAD Packages	SME V&V	10d	Mon 10/26/98	Fri 11/6/98
43	Prepare JAD V&V Results Report for JWARS Office and JAMIP SC	SME V&V	5d	Mon 11/9/98	Fri 11/13/98
44	JAMIP Approval of Iteration 4 JADs		1d	Mon 11/16/98	Mon 11/16/98
45	Prepare for User Group/SME Review of Iteration 4 CMMS/HLD/MVC	SME V&V	20d	Mon 11/9/98	Fri 12/4/98
46	Coordinate Review of Iteration 4 CMMS/HLD/MVC	SME V&V	10d	Mon 12/7/98	Fri 12/18/98
47	JAMIP Approval of Iteration 4 CMMS/HLD		1d	Mon 12/21/98	Mon 12/21/98
48	Prepare to Conduct DD Verification and Algorithm Validation	SME V&V	10d	Tue 12/22/98	Mon 1/4/99
49	Conduct DD Verification and Algorithm Validation	SME V&V	10d	Thu 1/7/99	Wed 1/20/99
50	Prepare DD Verification and Algorithm Validation Report to JWARS Office		5d	Thu 1/21/99	Wed 1/27/99
51	Prepare to Perform Implementation Verification		15d	Thu 1/28/99	Wed 2/17/99
52	Perform Implementation Verification	SME V&V	10d	Mon 2/22/99	Fri 3/5/99
53	Conduct Results Validation	SME V&V	30d	Fri 4/9/99	Thu 5/20/99
54	Prepare Iteration 4 JWARS Interim V&V Report	SME V&V	60d	Mon 3/8/99	Fri 5/28/99
55	Deliver Iteration 4 JWARS Interim V&V Report to JAMIP	SME V&V	0d	Mon 5/31/99	Mon 5/31/99
56					
57	Perform V&V on Iteration 5		270d	Mon 12/21/98	Mon 1/3/00
58	Plan and Schedule V&V Tasks	SME V&V	5d	Mon 12/21/98	Fri 12/25/98
59	Review Iteration 5 JAD Packages	SME V&V	21d	Fri 1/15/99	Fri 2/12/99
60	Coordinate User Group/SME Review of Iteration 5 JAD Packages	SME V&V	10d	Mon 2/15/99	Fri 2/26/99
61	Prepare JAD V&V Results Report for JWARS Office and JAMIP SC		5d	Mon 3/1/99	Fri 3/5/99
62	JAMIP Approval of Iteration 5 JADs		1d	Mon 3/8/99	Mon 3/8/99
63	Prepare for User Group/SME Review of Iteration 5 CMMS/HLD/MVC	SME V&V	14d	Tue 3/9/99	Fri 3/26/99
64	Coordinate Review of Iteration 5 CMMS/HLD/MVC	SME V&V	10d	Mon 3/29/99	Fri 4/9/99
65	Prepare CMMS/HLD V&V Report for JWARS Office and JAMIP SC		5d	Mon 4/12/99	Fri 4/16/99
66	JAMIP Approval of Iteration 5 CMMS/HLD		1d	Fri 4/16/99	Fri 4/16/99

UNCLASSIFIED

JWARS/V&V Plan/ver 3.0/13 August, 1998 **Joint Warfare System Verification and Validation Plan**

ID	Task Name	Resource	Duration	Start	Finish
67	Prepare to Conduct DD Verification and Algorithm Validation	SME V&V	5d	Mon 4/19/99	Fri 4/23/99
68	Conduct DD Verification and Algorithm Validation	SME V&V	5d	Mon 4/26/99	Fri 4/30/99
69	Prepare DD Verification and Algorithm Validation Report to JWARS Office		5d	Mon 5/3/99	Fri 5/7/99
70	Perform Implementation Verification	SME V&V	10d	Mon 6/14/99	Fri 6/25/99
71	Conduct Results Validation in conjunction with beta testing	SME V&V	130d	Mon 6/28/99	Fri 12/24/99
72	Prepare Iteration 5 JWARS Interim V&V Report	SME V&V	5d	Mon 12/27/99	Fri 12/31/99
73	Deliver Iteration 5 JWARS Interim V&V Report to JAMIP	SME V&V	0d	Mon 1/3/00	Mon 1/3/00
74					
75	Perform V&V on Iteration 6		290d	Mon 4/12/99	Mon 5/22/00
76	Plan and Schedule V&V Tasks	SME V&V	5d	Mon 4/12/99	Fri 4/16/99
77	Review Iteration 6 JAD Packages	SME V&V	21d	Fri 5/7/99	Fri 6/4/99
78	Coordinate User Group/SME Review of Iteration 6 JAD Packages	SME V&V	10d	Mon 6/7/99	Fri 6/18/99
79	Prepare JAD V&V Results Report for JWARS Office and JAMIP SC		5d	Mon 6/21/99	Fri 6/25/99
80	JAMIP Approval of Iteration 6 JADs		1d	Mon 6/28/99	Mon 6/28/99
81	Prepare for User Group/SME Review of Iteration 6 CMMS/HLD/MVC	SME V&V	14d	Mon 6/21/99	Thu 7/8/99
82	Coordinate Review of Iteration 6 CMMS/HLD/MVC	SME V&V	10d	Fri 7/16/99	Thu 7/29/99
83	Prepare CMMS/HLD V&V Report for JWARS Office and JAMIP SC		5d	Fri 7/30/99	Thu 8/5/99
84	JAMIP Approval of Iteration 6 CMMS/HLD		1d	Fri 8/6/99	Fri 8/6/99
85	Prepare to Conduct DD Verification and Algorithm Validation	SME V&V	5d	Mon 8/9/99	Fri 8/13/99
86	Conduct DD Verification and Algorithm Validation	SME V&V	5d	Mon 8/16/99	Fri 8/20/99
87	Prepare DD Verification and Algorithm Validation Report to JWARS Office		5d	Mon 8/23/99	Fri 8/27/99
88	Perform Implementation Verification	SME V&V	10d	Mon 11/1/99	Fri 11/12/99
89	Conduct Results Validation in conjunction with beta testing	SME V&V	130d	Mon 11/15/99	Fri 5/12/00
90	Prepare Iteration 6 JWARS Interim V&V Report	SME V&V	5d	Mon 5/15/00	Fri 5/19/00
91	Deliver Iteration 6 JWARS Interim V&V Report to JAMIP	SME V&V	0d	Mon 5/22/00	Mon 5/22/00

APPENDIX B: REFERENCED DOCUMENTS

1. Defense Modeling and Simulation Office (DMSO), *DoD VV&A Recommended Practices Guide*, November 1996.
2. Defense Modeling and Simulation Office (DMSO), *HLA Management Plan, ver 1.6*, 17 July 1995.
3. Department of Defense, *DoD Directive 5000 series (5000.1 and 5000.2)*,
4. Department of Defense, *DoD Directive 5000.59, DoD Modeling and Simulation (M&S) Management*, January 4, 1994.
5. Department of Defense, *DoD Directive 5000.59-M, DoD Modeling and Simulation (M&S) Glossary*, January, 1998.
6. Department of Defense, *DoD Directive 5000.59-P, DoD Modeling and Simulation (M&S) Master Plan*, October, 1995.
7. Department of Defense, *DoD Instruction 5000.61, DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation (VV&A)*, April 29, 1996.
8. *JWARS High Level Problem Domain Detailed Design Document, Version 1.4*, May 1, 1998.
9. *JWARS Conceptual Model of the Mission Space (JCMMS) Document, Version 1.2*, 6 June 1998.
10. Illgen, *JWARS VV&A Plan, Version 1.0*, November 18, 1996.
11. Illgen, *JWARS V&V Plan, Version 2.0*, October 31, 1997.
12. Johns Hopkins University Applied Physics Lab (JHU/APL), *Final JWARS Prototype Assessment*, April 1997.
13. Joint Staff, *Joint Staff Instruction 8104.01, Verification, Validation, and Accreditation of Joint Models and Simulations*, January 12, 1995.
14. Joint Staff, J-8/SAMD, *JWARS Configuration Management Plan, Version 2.0 (Draft)*, 24 July, 1998.
15. Joint Staff, J-8, *JWARS Draft Operational Requirements Directive (ORD)*, 1 December 1997.

UNCLASSIFIED

JWARS/V&V Plan/ver 3.0/13 August, 1998 **Joint Warfare System Verification and Validation Plan**

16. JWARS Office, *JWARS Draft Operational Requirements Document (ORD)*, Version 1.6, July 13, 1998.
17. JWARS Office, *JWARS Software Project Management Plan*, Version 1.2, April 24, 1998.
18. JWARS Office, *JWARS Overview Briefing*, Version 4.0, January 30, 1998.
19. JWARS Office, *User Interviews*, November 25, 1997.
20. Prosser, Terry, *White Paper, JWARS Software Development Process*, December 13, 1996.
21. JWARS Office, *JWARS Schedule*, Version 1.8, June 29, 1998.

APPENDIX C: GLOSSARY OF TERMS

Product Name	Product Description
Application Software	An executable JWARS Model.
Certified Data	Certification establishes that the data are suitable for a specific use. (<i>DoD VV&A RPG, November 1996, page 1-29</i>)
Conceptual Model (the JWARS software development process does not include a Conceptual Model; the Conceptual Model will be made up of the activities and products leading up to, but not including, Detailed Design)	A Conceptual Model is a simulation developer's way of translating modeling requirements into a Detailed Design framework, from which the software that will make up the simulation can be built. A Conceptual Model typically consists of a description of how the modeling requirements were broken down into model-able pieces, how those pieces fit together and interact, and how they work together to meet the requirements specified. It also should include a description of the equations and algorithms that will be used to meet the requirements, as well as an explicit description of any assumptions or limitations made or associated with the equations, algorithms, or solution approaches that were used to solve the modeling problem. The Conceptual Model should also identify how these assumptions and limitations might impact the simulation's ability to meet requirements, once it is built. (<i>DoD VV&A RPG, November 1996, page 1-6</i>)
Conceptual Model of the Mission Space (CMMS)	A CMMS documents the real world processes that have to be represented in the model. The JWARS Mission Space Model documents the basis of the JWARS Object Model. Knowledge concerning the Problem Domain component of the JWARS Application Program is captured in a database and in executable diagrams for use by software engineers in performing object-oriented (OO) analysis and object-oriented design. The JWARS Mission Space Model evolves the JM&SRG requirements to a derived form from which an object model may be constructed. <i>JWARS High Level Problem Domain Detailed Design Document, Version 1.4, May 1, 1998.</i>
High Level Design (HLD)	JWARS HLD is an initial class declaration for objects. It is typically the first OO abstraction of the mission space. It includes object classes with attribute names, event trace and data flow diagrams, plus functional diagrams. The HLD applies to all three components of the JWARS architecture: the military problem domain, the platform domain, and the simulation architecture. (White Paper on JWARS Software Development Process, December 13, 1996, Version 1.0, page 25.) The JWARS HLD is the product of the application of the Object Modeling Template (OMT) System Design. The JWARS HLD describes the JWARS System Architecture which includes the JWARS Application Program. This document is the capstone of the documents described. <i>JWARS High Level Problem Domain Detailed Design Document, Version 1.4, May 1, 1998.</i>
Implementation Data	Data provided by the JDS for specific JWARS scenarios.
Interim V&V Reports	Reports produced at the end of each of the V&V steps. Interim reports are input to the final V&V report.

Product Name	Product Description
Joint Application Design (JAD) Package	The JAD packages used in JWARS development are the products of a structured JAD session that brings together users, managers, and developers to jointly define and specify user requirements, technical options, and external designs. It is part of the systems analysis phases, especially requirements definition. JADs are an attempt to solicit greater user and management participation in the systems development life cycle. It is designed to get the requirements (as specified in the ORD), User Interviews, and Program Developer SOWs defined and prioritized at the earliest stages of the process. JADs frame the CMMS and insure they address the required functionality for the software development threads in the package. They also may provide some algorithms for the HLD. ⁸
M&S Code	The software code produced from the results of the Detailed Design process.
M&S Implementation Integration Test Results	The results of the software code implementation and the integration tests. This step completes the engineering of the software development thread. (<i>White Paper - JWARS Software Development Process, December 13, 1996, Version 1.0, page 18.</i>)
Military and Environmental Representation Requirements	Derived requirements from the ORD that list the military representations and the environmental representations required in JWARS.
Model Validation Criteria (MVC)	MVC are a product of the V&V Agent working with the Development Contractors based upon the requirements. Validation criteria metrics establish the quantitative measures on which to base model design (the extent to which a model must function), and are the basis for determining the adequacy of model functionality from the perspective of intended use for results validation.
Summary V&V Reports	The reports provided by the V&V process for use in the accreditation process.
System Design Requirements	Derived requirements for the simulation from the ORD. Requirements include: hardware performance; software capabilities; HLA compliance; CM; manpower constraints; connectivity; timeliness; mobility; availability; and maintainability.
User Requirements	Derived requirements from the ORD and User Interviews that describe what the user community wants JWARS to do, and how they would like to do it. Current user-oriented features include: scenario generation; display / user interface; pre-processing; run control; documentation; training; data availability; variable resolution; transparency; and Course of Action (COA) development.
Validated Application Software	A version of the JWARS software that has been through a complete V&V process and is ready for the accreditation process for a specific use.

V&V Process	V&V Process Description
CMMS Validation	CMMS Validation is the process of SME review to determine that the mission space information required for the simulation is properly described.
Code Verification	The process of determining that the software code produced accurately conforms to the Detailed Design.
Conceptual Model Validation	Conceptual Model Validation is the determination (usually by a group of SMEs) that the assumptions underlying the proposed Conceptual Model are correct, and that the proposed simulation design elements and structure (i.e., the simulation's functions, their interactions, and outputs) likely will lead to results realistic enough to meet the requirements of the application. (<i>DoD VV&A RPG, November 1996, page 1-8</i>)

⁸ This description of a JAD is taken from Systems Analysis and Design Methods, 3rd edition, pages 156 and 157. The JWARS Office has modified the JAD process to meet their development needs.

V&V Process	V&V Process Description
Conceptual Model Verification	The process of reviewing the Conceptual Model and ensuring it meets your specified requirements. Conceptual Model Verification ensures that the proposed Conceptual Model (and its resultant design) satisfies the fidelity, accuracy, or credibility requirements imposed by the specifics of your problem. <i>(DoD VV&A RPG, November 1996, page 1-6 and 1-8)</i>
Detailed Design Verification	The process of reviewing the Detailed Design to be sure it conforms to the Conceptual Model is called Design Verification. <i>(DoD VV&A RPG, November 1996, page 1-6)</i> For JWARS, the DD will be the comparison benchmark, providing for the traceability of requirements
HLD Verification	HLD conforms to the Design as described in the JAD packages; also, requirements traceability from the ORD is examined and verified for the functionality required for the threads in the iteration. HLD Verification is the process of evaluating how well the Representation Criteria and system design requirements are addressed in the HLD. Verification of HLD is comparison of amalgam of the CMMS, the Representation Criteria, and the System Design requirements.
Implementation Verification	Once the implementation of the design is completed in code, the results of the model or simulation are formally reviewed (i.e., documented). Responses of the model or simulation are compared against known or expected behavior from the subject it represents to ascertain that the M&S responses are sufficiently accurate for the intended use. The developer of a model with stochastic processes is expected to provide guidance regarding the number of iterations required for statistically significant results. <i>(DoD VV&A RPG, November 1996, page 3-20).</i>
JAD V&V	<p>A JAD is verified by the V&V Agent to determine if the derived requirements (the military and environmental representations and user requirements) meet the intent of the user requirements and other higher level requirements documents. JAD verification includes the process of determining that the JAD is properly formatted, consistent, and complete. Verification determines that the JAD includes: the proper candidate objects, post processing for the EEA (and associated Measures of Merit (MOMs)), supports the developmental test case, and has the required external data available. Verification of the context diagram, level one decomposition, event trace diagram, and test case diagram is the final JAD V&V step.</p> <p>JAD validation is conducted by the SME/user community in three distinct steps. Step 1 is the pre-JAD Session review and comments back to the V&V Agent and/or the IPT Lead. Step 2 is attending the JAD Session and making comments and changes to the JAD. Step 3 is post-JAD Session review of the final JAD product and comments for changes back to the V&V Agent.</p>
MVC Approval	Approval by the JWARS Office that the proposed MVC are acceptable for use in the remaining JWARS development and V&V processes.
Results Validation	Results Validation compares the responses of the simulation with known or expected behavior from the subject it represents to ascertain that those responses are sufficiently accurate for the range of intended uses of the simulation. The process includes comparison of simulation outputs with the results of controlled tests, sensitivity analyses, or expert opinion. For JWARS, Results Validation will also assess the ability of the model to meet model validation criteria. <i>(DoD VV&A RPG, November 1996, page 1-6 and 1-8)</i>